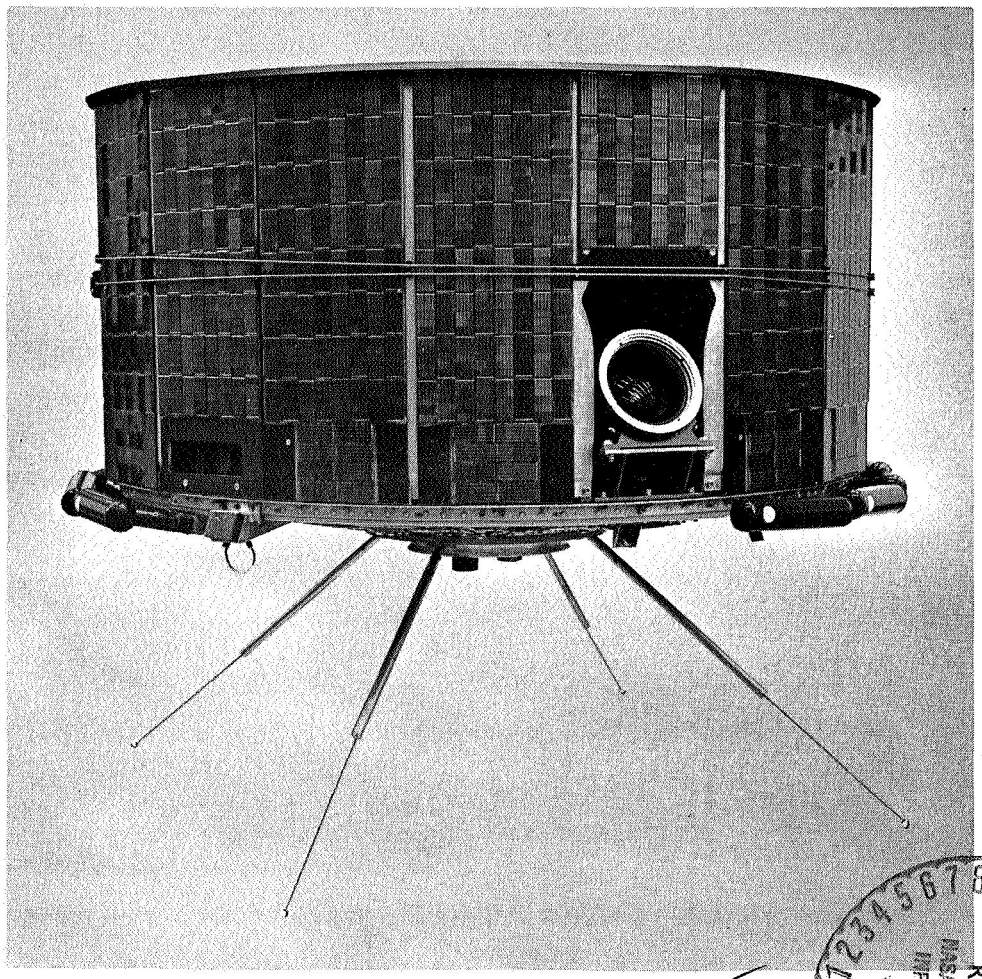
DELTA-28

FLASH FLIGHT REPORT



TIROS-I

GODDARD LAUNCH OPERATIONS

EASTERN TEST RANGE

GODDARD SPACE FLIGHT CENTER,
GREENBELT, MARYLAND

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DELTA-28

TIROS-I

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Approved:

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ABSTRACT

This report presents a brief summary of the prelaunch activities and launch operations of the DELTA-28 vehicle and the TIROS-I spacecraft on January 22, 1965, from Cape Kennedy, Florida. Because of the short period of time allotted for the publication of this report and the lack of some downrange data, only preliminary analyses of vehicle flight performance and launch phase data acquisition are presented. The comprehensive Field Flight Report, which will be published at a later date, will include a more detailed analysis of all data.

TABLE OF CONTENTS

SUMMARY

DELTA-28 with the TIROS-I spacecraft was launched from Pad 17A of Complex 17 at Cape Kennedy, Florida, on January 22, 1965, at 0252:00.4 EST (ETR Test No. 285).

Range data indicates an abnormal IIP for a portion of first stage flight; however vehicle programming appears normal. First stage telemetry was lost at MECO+4 seconds. Loss of WECO guidance during second stage burning before planned SECO caused the second stage to burn to oxidizer depletion. This caused the spacecraft to be injected into an elliptical orbit. The third stage performed satisfactorily.

Data acquisition from the Cape and downrange stations was good.

Spacecraft separation has been confirmed; spin rate appears to be nominal.

The weather during the countdown was generally good, with only intermittent showers. The only hold that occurred was the scheduled 60-minute built-in hold at T-35 minutes.

Only nominal pad damage occurred; however, the first stage fuel mast failed to retract properly.

I. LAUNCH OBJECTIVES AND DESCRIPTION

The objectives of this launch were to place the TIROS-I spacecraft into a 400-nautical mile, near polar, sun-syncronous orbit with an inclination of 81.64 degrees retrograde and an orbit period of 99.6 minutes.

The DELTA-28 vehicle (374/20107/RH-79) with the TIROS-I spacecraft was launched from Complex 17, Pad A, at Cape Kennedy, Florida, on January 22, 1965, at 0252 EST. Because of a longer than planned second stage burn time caused by a loss of the WECO guidance, the spacecraft was injected into an elliptical orbit of approximately 1500 nautical miles apogee and 400 nautical miles perigee.

II. WEATHER

The weather at T-0 was clear, with no cloud cover. There were intermittent showers during the countdown.

The temperature was 59.8°F. Humidity was 95 percent. There were no surface winds. There were no significant wind shears.

Upper air winds were as follows:

Altitude (feet)	Velocity (knots)	Direction (degrees)
5,000	11	134
10,000	16	272
15,000	20	267
25,000	37	251
50,000	46	237
100,000	38	262

III. FLIGHT PERFORMANCE

A. TRAJECTORY AND RANGE SAFETY

1. First Stage

Present position during first stage burning was approximately 1.5 n mi (4 sigma) high and .75 n mi (2 sigma) left of nominal. The impact point trace was about 1-sigma left of nominal until T+93 seconds. At this time the trace diverged to 5-sigma left at 115 seconds. WECO guidance then began making corrections and the IP trace returned to slightly right of nominal at MECO. The charts indicated that first stage vacuum IIP was 40 n mi downrange and 2 n mi to the right of the nominal IIP. No action was taken by the RSO during the time the IIP trace was outside the 3-sigma left trace because the trace had passed through the Range Safety gate at T+93 seconds and there were no destruct lines on the left until T+136 seconds. Although the IIP trace went beyond the MAFCO line, the RSO did not send MAFCO.

2. Second Stage

During second stage burning, the present position changed from high and left to 10 n mi low and slightly right at SECO. The impact point diverged to 1-sigma right (about 40 n mi) and was 360 n mi downrange of nominal SECO IIP because of PDS shutdown instead of WECO cutoff. No Range Safety difficulties were experienced during second stage burning.

3. Third Stage

Initial indications are that the third stage performance was higher than nominal, with a burn time of 22.7 seconds.

B. SEQUENCE OF EVENTS

The significant flight events as calculated at Hangar AE are listed below. Those events which occurred before MECO are given in seconds after liftoff. Those events which occurred after MECO are given in seconds after MECO (M+seconds).

EVENT	EXPECTED TIME	ACTUAL TIME
Liftoff	T+0 (0252 EST)	T+0 (0252:00.4 EST)
MECO	T+142.8	T+140.5
Stage I/II Separation	M+4	M+4
Stage II Ignition	M+4	M+4
Jettison Fairing Command	M+84	M+84
SECO	M+164.2	M+179.6
Spinup	M+619.5	M+619 5
Stage II/III Separation	M+621.5	M+621 5
Stage III Ignition	M+625.5	M+625.6
Stage III Burnout	M+648	Not recorded

179 6
164 2
15.4

C VEHICLE PERFORMANCE

1. Propulsion

a. First Stage

Preliminary data indicates above nominal first stage performance. Total steady state thrust at liftoff + 25 seconds was 175,000 pounds. Turbopump speed, turbine temperature, and gas generator LOX injector pressure reflect the higher than nominal performance. Both main tank pressures and the pump inlet pressures also indicate a normal flight

First stage burning time was 140.5 seconds, which is approximately 2 seconds shorter than the DTO predicted. It should be noted that the predicted DTO time was based on loading the fuel and oxidizer of the first stage to the 97 percent level To facilitate accurate oxidizer loading, the 95 percent oxidizer probe was reset to the

97 percent level. No problems were encountered in loading to this level.

Vernier engine performance was nominal; however, data was lost at stage I/II separation and a solo burn time cannot be determined at this time.

Hydraulic pressure was normal on all data presently available.

The fuel mast did not retract at liftoff; however, at this time it appears that no significant vehicle damage occurred.

b. Second Stage

Second stage performance was nominal during steady state operation. Helium tank pressure was low at liftoff, at 1590 psig, which accounted for a shorter than normal steady state thrust level of approximately 116 seconds. HGA ignition occurred at second stage ignition plus 5 seconds. The fuel and oxidizer tank pressures were 328 psia and 335 psia, respectively.

Retro system pressure was 2895 psia throughout first and second stage operation. Retro system operation occurred at Sequence 5 (third stage/second stage separation), and indicated normal operation.

Hydraulic system performance was satisfactory at 1020 psig throughout second stage operation. Decay at SECO was normal.

Time of second stage shutdown (SECO) was later than predicted, and was produced by the oxidizer probes because of a loss of WECO guidance.

c. Third Stage

Preliminary doppler data from both Key West, Florida, and Lima, Peru, indicate a burn time of 22.75 seconds for the X-258 third stage. Tracking data on the initial pass also confirms a normal third stage.

2. Guidance and Controls

a. First Stage

The first stage control system performed satisfactorily. Liftoff transients were higher than usual; probably this can be attributed to the fact that the fuel mast did not retract properly. This transient was noted as a 0.75 degree per second peak-to-peak oscillation on the pitch rate channel; the oscillation was adequately damped within five seconds. Vehicle response was proper. Maximum "Q" pitch and yaw main engine excursions were 0.80 degree pitch up and 1.05 degrees yaw right.

WECO started steering at T+112 seconds. Initial steering commands were pitch down and yaw right. The last first stage WECO commands occurred at T+136 seconds.

A gradual decay of WECO AGC commenced at T+90 seconds, with some abnormal deteriorations noted during this decay. This decay continued during second stage operations. Vehicle disturbances encountered at gain change and MECO were small and vehicle response to these disturbances was normal. Inverter, flight control, instrumentation, actuator potentiometer positive voltages were normal.

All first stage programmed events occurred on time and were of the proper magnitude. Second stage arm bus was powered by "g" switch closure at T+108 seconds.

Thrust misalignment of the first stage at MECO was neglible in yaw and 0.20 degree pitch down.

b. Second Stage

Thrust misalignment during second stage powered flight was less than 0.1 degree in both pitch and yaw. All programmed events occurred on time. Inverter and battery voltages were good. There was a first/second stage separation transient reflected on the pitch attitude gyro of 0.14 degree.

SECO was initiated by oxidizer depletion at M+179.6 seconds as loss of WECO guidance occurred before nominal SECO time.

Initial WECO steering command commenced at M+15 seconds and terminated at M+67 seconds.

There was a magnetron current dropout at second stage ignition for approximately three seconds. This is for a longer period of time than usually experienced for ignition ionization.

WECO automatic gain control (AGC) decay which commenced during first stage operation, continued during second stage flight. This AGC level reached a marginal level and the WECO airborne guidance package shutoff at M+126.6 seconds. This condition could possibly be attributed to an incorrect placement of the vehicle vertical guidance antenna.

c. Coast Flight

Coast flight was properly initiated at SECO and adequately damped the transfer to coast flight transients. The gyros did not exceed their preset dead zones (up to loss of telemetry signal at the Cape).

The spin rate at second/third stage separation was 129 rpm. At this time vehicle errors and rates were 0.12 degree vehicle down, 0.05 degree per second vehicle down, and 0.08 degree vehicle left moving at 0.07 degree per second yaw left.

IV. DATA ACQUISITION AND VEHICLE INSTRUMENTATION

A. DATA ACQUISITION

1. Optics

There were 9 metric, 20 engineering sequential, and 8 documentary cameras committed to this launch. One metric camera at Station 1 did not operate. The engineering sequential camera at Station 3 only acquired 50 percent coverage. All other cameras operated properly.

2. Tracking

Eight radars were committed to this launch. Coverage was obtained from T+0 (TV) to T+801 seconds.

First and second stage impact prediction data was provided by radar 19.18.

3. Telemetry

Vehicle telemetry was received at ETR Stations 1 (Tel-2 and Tel-3), 3, 5, and 7, and at Hangar AE. Spacecraft telemetry was received at ETR Stations 1 (Tel-3), and 3. Vehicle telemetry was also acquired by an ETR aircraft and two WTR aircraft.

Continuous vehicle coverage was obtained by the Range from T-120 seconds to T+1514 seconds.

A real time presentation of the second stage 3.9 kc subcarrier from Station 7 was available at Tel-2 and Hangar AE for real time readout of spinup and separation.

Key West, Quito, Ecuador, and Lima, Peru, were given telemetry band receiving gear. Satisfactory coverage was obtained from these stations through 1600 seconds.

A post-test playback of the Station 7 data, at half-speed to accomodate the low frequency response of the subcable, was made at Tel-2. This was later played back at Hangar AE, and showed all measurements through ignition of stage 3.

4. Tracking Stations

a. GLO Satellite Tracking Station

Equipment for acquisition of doppler data during the DELTA-28/TIROS-I launching was located at Cape Kennedy, at Key West, Florida, and at the STADAN station at Lima, Peru, in order to observe all phases of powered flight. The spacecraft 136.23 mc beacon was tracked by these stations and recordings of spacecraft signal levels (AGC) and received frequency for doppler shift were made

The Satellite Tracking Station at Cape Kennedy tracked the signal until loss over the radio horizon at T+700 seconds. The first and second stage powered flight portion was observed. First stage cutoff was observed at T+140.5 seconds and second stage cutoff (SECO) at T+320 seconds. The doppler shift at SECO was approximately 155 cps above nominal because of an approximately 15 second longer burning time than planned for the second stage.

The Key West doppler station observed third stage ignition at T+766.6 seconds, but lost the spacecraft signal over the horizon before burnout of the stage because of the above nominal performance of the second stage. The signal was lost at T+783.5 seconds.

The Lima, Peru station acquired the spacecraft signals and observed third stage ignition at T+766 6 seconds. Third stage burnout was also observed and are reported to have occurred at T+789 35 seconds, giving a third stage burning time of 22 5 seconds.

The STADAN station at Santiago, Chile, reported separation of the spacecraft from the third stage and despin of the spacecraft to 9 rpm

The first pass of the TIROS-9 (1965-04A) satellite was acquired at the Cape Kennedy Satellite Tracking Station at 0448 EST, which was later than expected.

Because of the above nominal velocity, the desired circular orbit was not achieved. The first orbital predictions from early tracking data were:

1	Apogee	1392 n mi	400 n mi
2	Perigee	378 n mi	400 n mi
3	Inclination	96 degrees	98.36 degrees
4	Period	119 min.	99.6 min.

b. ELSSE

ELSSE tracked from T+4 seconds until T+630 seconds.

B. VEHICLE INSTRUMENTATION

1. First Stage

Stage 1 telemetry data was of high quality, with no dropouts or lost measurements noted through MECO. However, about 0.1 second after stage II ignition (measured from chamber pressure buildup) all FM/FM channels, including the 70 kc with PDM multicoder, dropped to zero level (low frequency bandedge) and remained there until somewhere in the mixer, video amplifier, or modulator. No abnormal vehicle motions, pressures, or temperatures are noted at this time, so it appears to be a telemetry problem.

2. Stage Stage

Stage II telemetry data was of high quality also. No dropouts were seen, except that at stage II ignition, which was probably the least severe observed on DELTA to date. No lost measurements have been reported.

V. PRELAUNCH OPERATIONS

A. T-6 DAY ACCEPTANCE AND RFI TEST

The Acceptance and RFI Test was conducted on January 11. The test was started at 0830 EST and was completed at 1150 EST. The following problems were experienced during the test:

1. A high drift rate was noted on the second stage pitch gyro. The unit was returned to the electronics lab for checkout and recalibration.

2. During the internal power run, the second stage engine was erratic in pitch. This problem was isolated to the second stage pitch feedback potentiometer which was replaced.

3. CDR checks were delayed because of Range commitments on another test. The Range support was postponed midway through CDR #2 checks during the RFI checks with the tower moved away from the vehicle. These checks were accomplished satisfactorily when Range support became available.

4. When the umbilicals were remated to the vehicle after the internal run, it was noted that the flight control power supply was not on. Troubleshooting revealed this power supply had cycled off from an electrical transient on the voltage sense line when the umbilical was remated.

B. T-4 DAY OPERATIONS

The C-band beacon antenna was reoriented from $\phi = 90°$ to $\phi = 165°$, since recent studies indicated this to be a better position.

On January 14, the first stage inverter (-501) was replaced by inverter -503 because of reported poor workmanship in the -501 units.

C. T-3 DAY ALL SYSTEMS TEST

The T-3 Day All Systems Test, originally scheduled for 0830 EST on January 15, was rescheduled to 0700 EST on January 16 because of a first stage inverter problem. The newly installed -503 inverter failed the megger check for isolation between the input winding and the inverter case. During requalification on a replacement -501 inverter (-503 unit not available), the first stage yaw gyro exhibited erratic drift characteristics. The CEA was returned to the electronics lab on January 16 for yaw gyro replacement.

The T-3 Day test was rescheduled to 0830 on January 18. Vehicle requalification after the gyro replacement was accomplished on January 17.

The All Systems Test was started at 0830 EST on January 18 and was completed at 0955 EST. The following problems were noted:

1. Vernier engine No. 1 motion was noticed when the hydraulics were turned on during the external power run. Tests on this system were performed after the internal power run was completed. Air in the hydraulic line was believed to have caused the vernier engine movement as it did not recur during retest.

2. The 100 pps timing in the blockhouse stopped at 0921:43 EST during the internal power run. Timing from the Hangar M data lab was used for the remainder of the test.

3. Telemetry showed a phase shift in the first stage inverter. A new unit (-503) was flown in from Santa Monica, checked out, installed in the vehicle, and requalified on January 19.

D. T-1 DAY ELECTRICAL SYSTEMS CHECKS

1. Vehicle

The T-1 Day Electrical Systems Test was performed on January 19. The test started at 1430 EST and was completed at 1615 EST. During the test, the following problems occurred which necessitated a rerun of the task on January 20:

1 The spin rate switch stuck open several times during the test. The switch was replaced.

2 The second stage gyro drift rate in pitch was nonlinear. Two special slew checks were made on the gyro during the test, but the drift rate was still nonlinear. The gyro package was replaced and requalified.

3 The 32-volt maximum on the WECO guidance package was exceeded (32.4 vdc). A new package was installed, checked out, and requalified.

4 A small scratch was found on top of the first stage fuel tank. The scratch was through the protective coating and into the metal of the fuel tank. The scratch was satisfactorily sanded out and the surface was refinished.

2. Spacecraft

T-1 Day Spacecraft Checks began at 1230 EST and were completed at 1330 EST; no problems were encountered with the spacecraft.

The spacecraft telemetry systems were left on during stray voltage checks, which commenced at 1600 EST.

E. T-1 DAY ELECTRICAL SYSTEMS CHECKS (RERUN)

1. Vehicle

The T-1 Day Electrical Systems Test rerun was started at 1800 EST on January 20 and was completed at 1940 EST. The following problems were experienced:

1 The test was stopped for several minutes to allow the control battery voltage to drop below the 32-volt maximum that is required before the vehicle systems are switched to internal power.

2 Spurious steering commands were transmitted by the WECO guidance package when it was turned off. The package was cycled on and off several times and the anomaly occurred each time. The package was replaced and requalified.

2. Spacecraft

Spacecraft checks during the T-1 Day rerun were started at 1700 EST and satisfactorily completed at 1730 EST.

Spacecraft telemetry was turned on at 2020 EST to support the stray voltage checks, which were completed at 2200 EST.

F. T-0 DAY OPERATIONS

1. Vehicle

No problems occurred on T-0 Day. The countdown was started on time at 2010 EST on January 21 and progressed without interruption to the built-in hold. The terminal count was started on time at 0217 EST and continued uninterrupted to liftoff.

2. Spacecraft

Fairing installation was completed at 0632 EST on T-0 Day. Following this, spacecraft checks were started. These checks were satisfactorily completed at 0715 EST.

Spacecraft checks during the launch countdown were started at 2020 EST and were completed at 2050 EST with no problems.